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Bell et al.

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(54) **SECURE MEDICATION TRANSPORT**

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G16H 20/13 (2018.01)
G06F 19/00 (2018.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G16H 20/13*** (2018.01); ***A61J 7/0069*** (2013.01); ***A61J 7/0084*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC . A61J 7/0084; G06F 19/3462; G07F 17/0092
See application file for complete search history.

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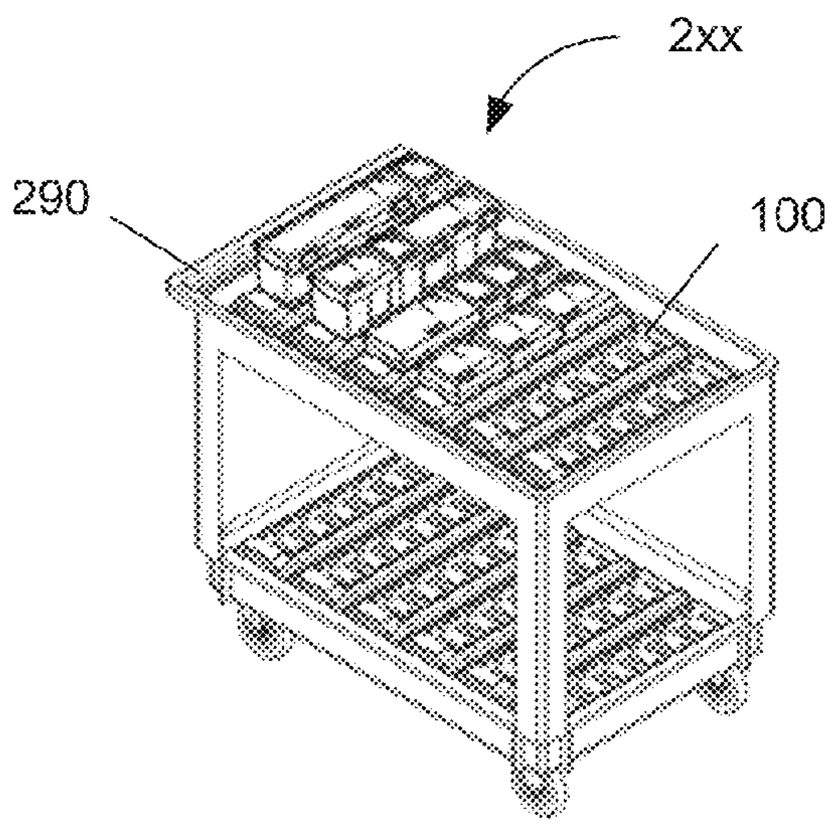
(57) **ABSTRACT**

A smart carrier has a housing comprising one or more docking locations configured to accept a secure receptacle, a wireless interface module disposed within the housing, and a processor disposed within the housing and operatively coupled to the one or more docking locations and the wireless interface module. The processor is configured to communicate with an external device through the wireless interface module and with a secure receptacle that is mated with one of the one or more docking locations. The smart carrier also has a battery disposed within the housing and configured to provide all operational power to the processor, the wireless interface module, and the one or more docking locations.

20 Claims, 7 Drawing Sheets



Related U.S. Application Data

division of application No. 13/931,623, filed on Jun. 28, 2013, now Pat. No. 9,600,634.

(51) **Int. Cl.**

A61J 7/00	(2006.01)
G07F 11/62	(2006.01)
G07F 17/00	(2006.01)
G07C 9/00	(2020.01)

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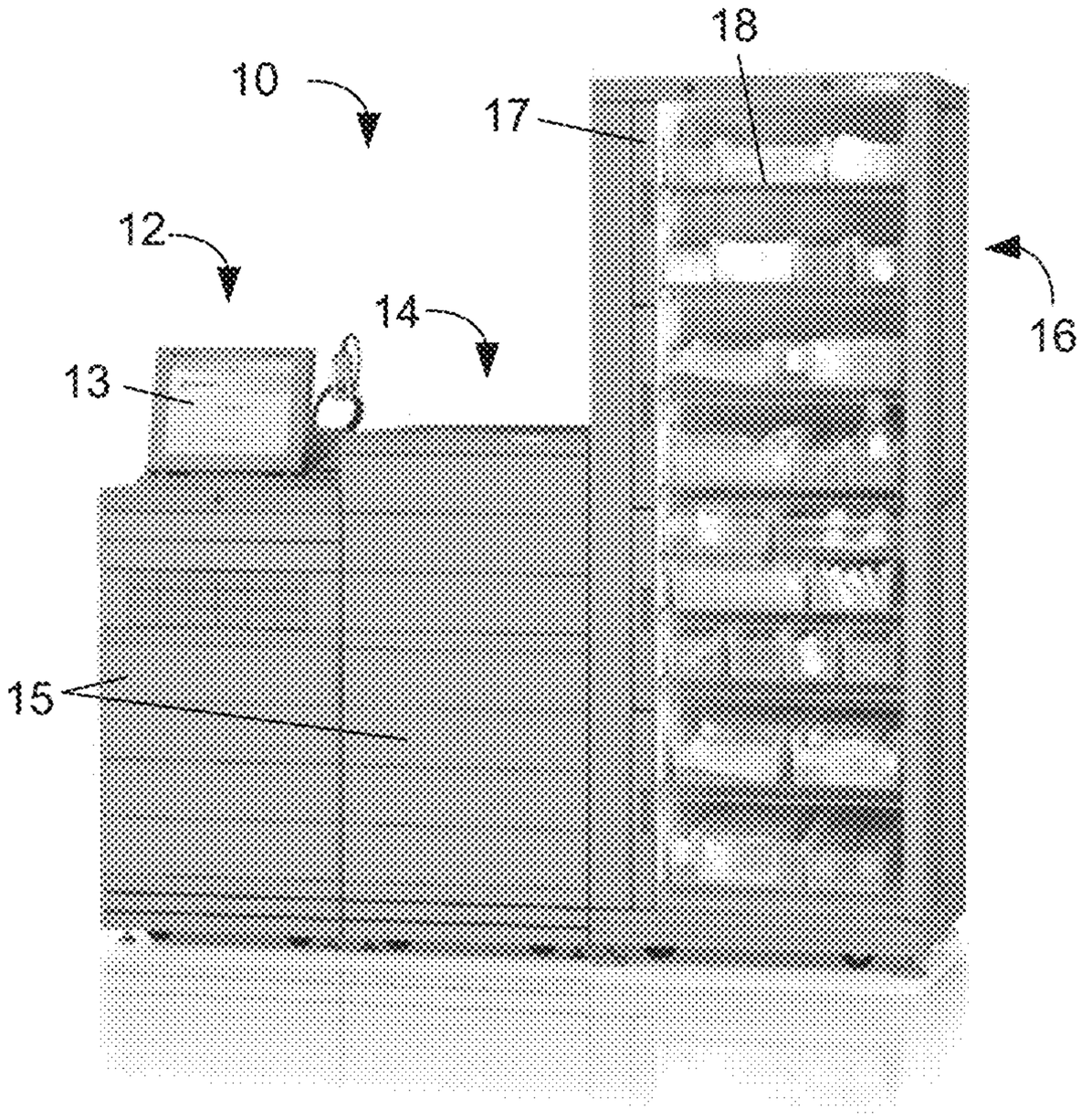

FIG. 1
PRIOR ART

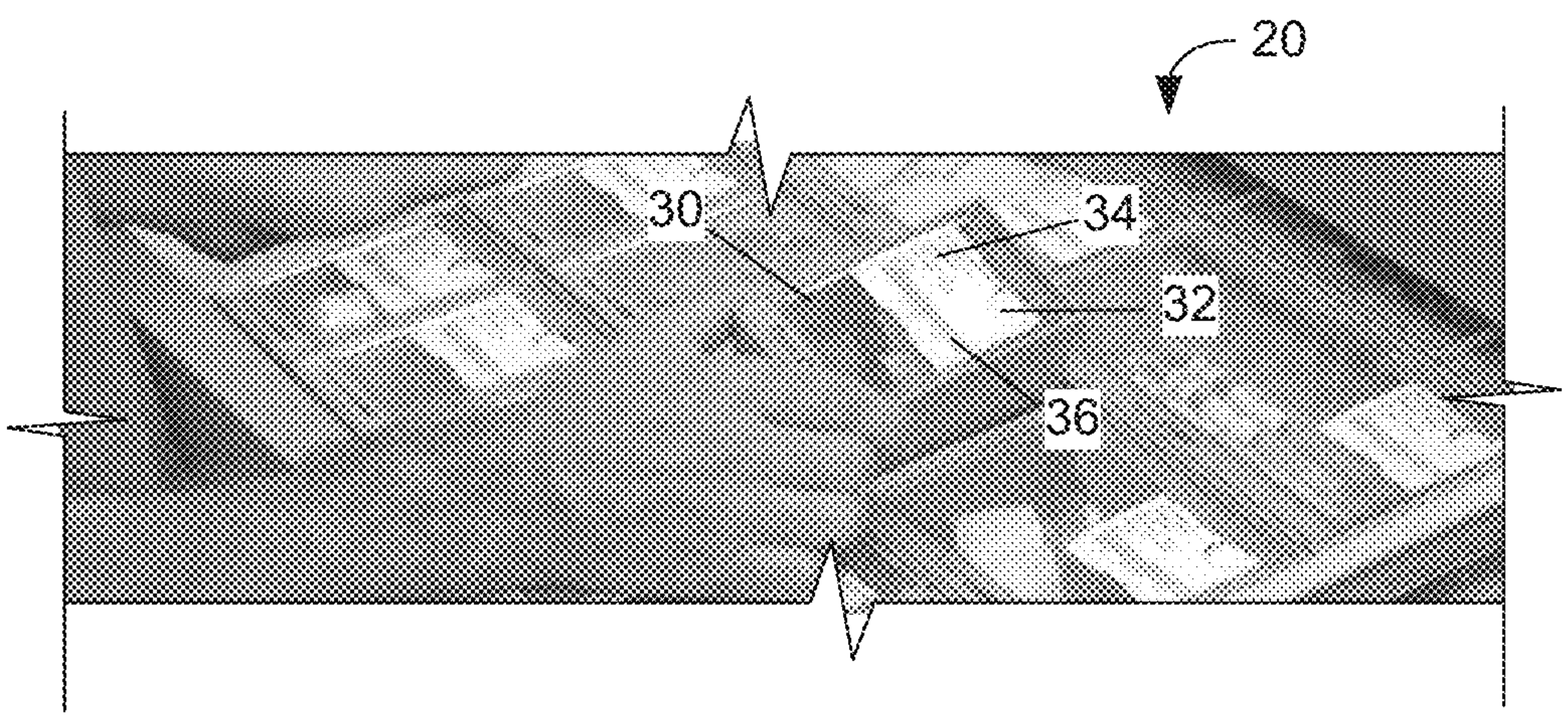

FIG. 2
PRIOR ART

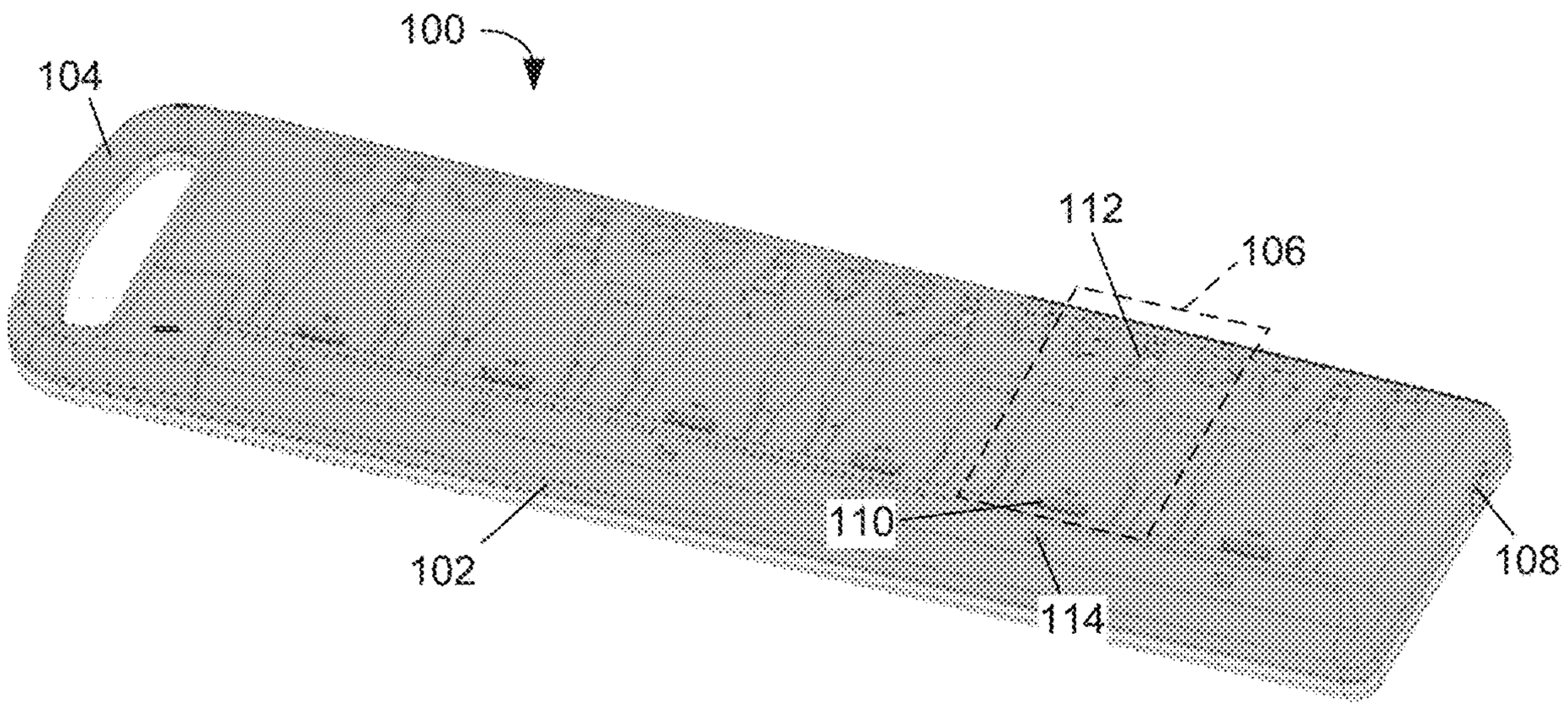

FIG. 3

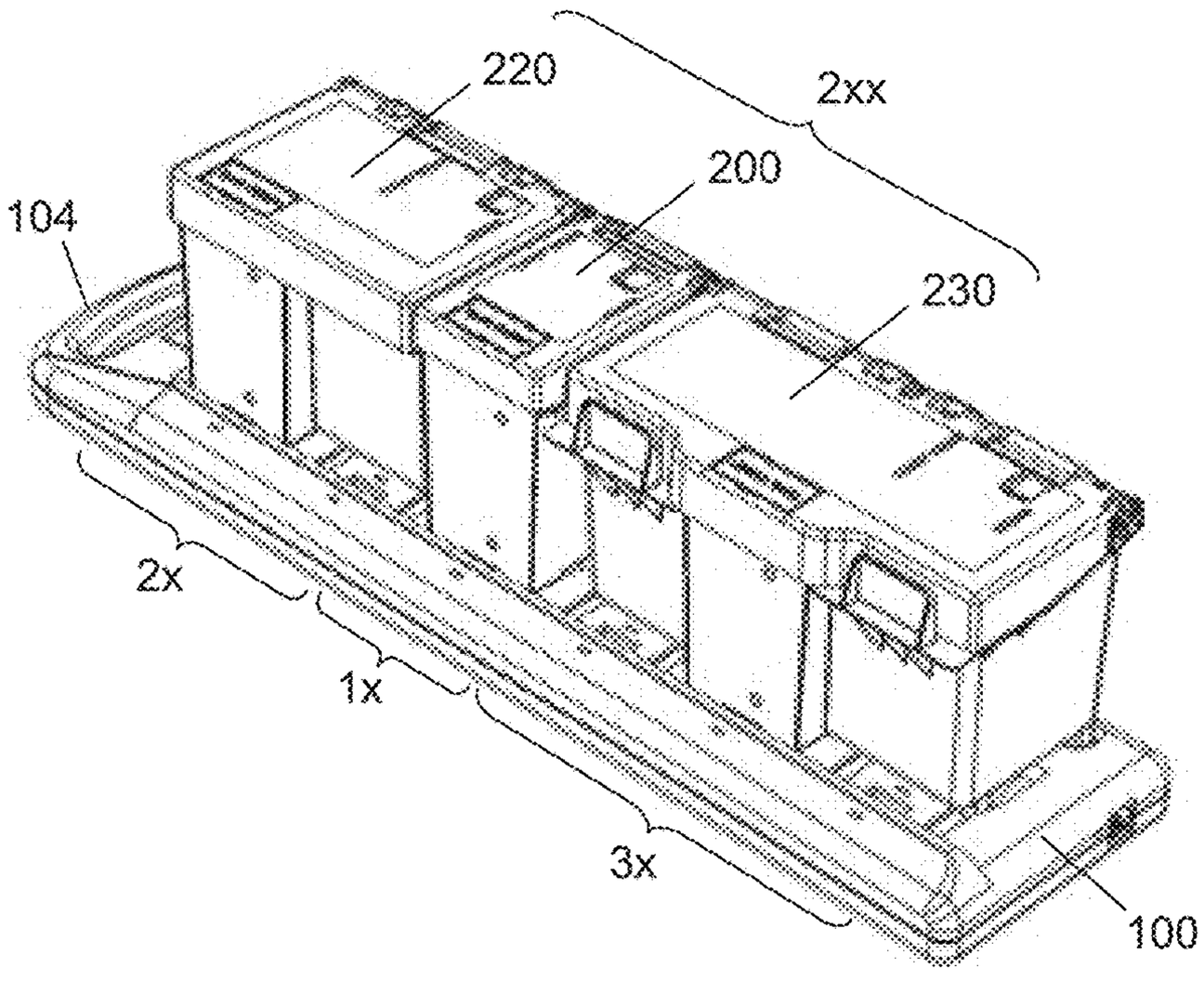

FIG. 4A

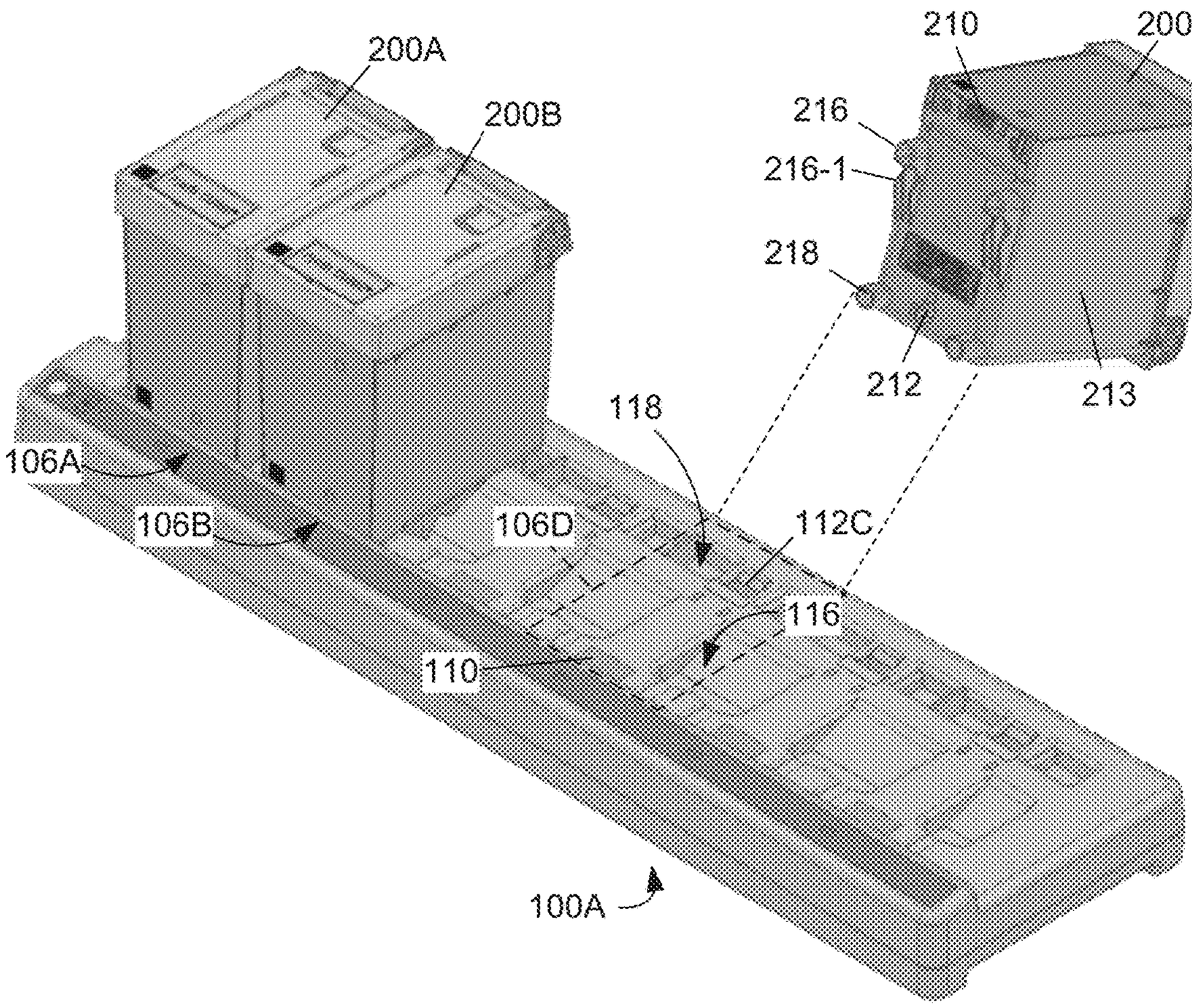
200A
200B
210
200C
216
216-1
218
212
213
118
106A
106B
106D
112C
116
110
100A

FIG. 4B

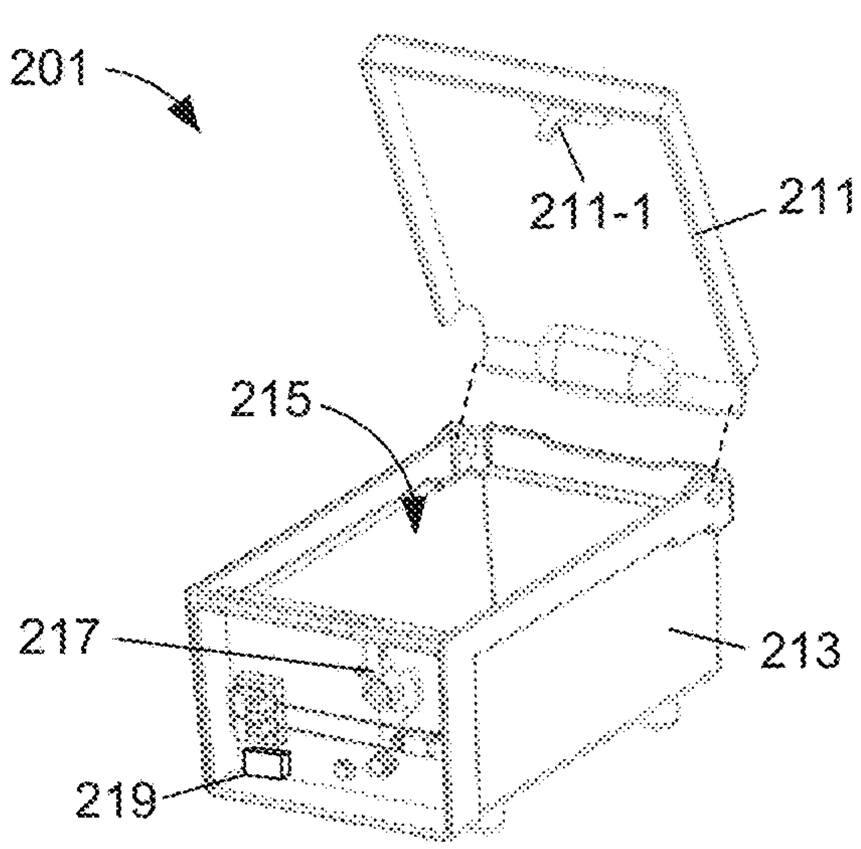
201
211-1
211
215
217
213
219

FIG. 4C

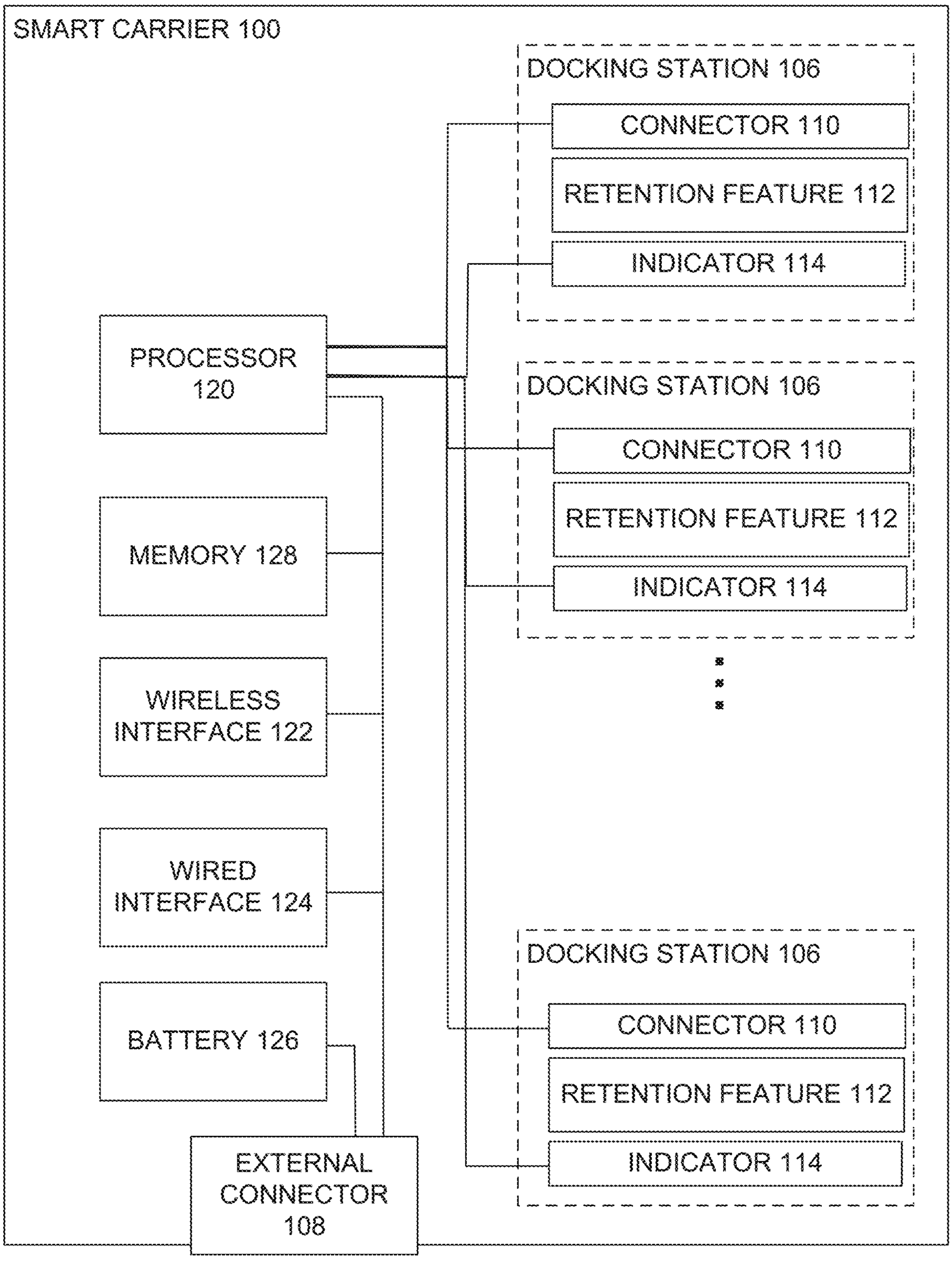
SMART CARRIER 100
PROCESSOR 120
MEMORY 128
WIRELESS INTERFACE 122
WIRED INTERFACE 124
BATTERY 126
EXTERNAL CONNECTOR 108
DOCKING STATION 106
CONNECTOR 110
RETENTION FEATURE 112
INDICATOR 114
DOCKING STATION 106
CONNECTOR 110
RETENTION FEATURE 112
INDICATOR 114
DOCKING STATION 106
CONNECTOR 110
RETENTION FEATURE 112
INDICATOR 114

FIG. 5

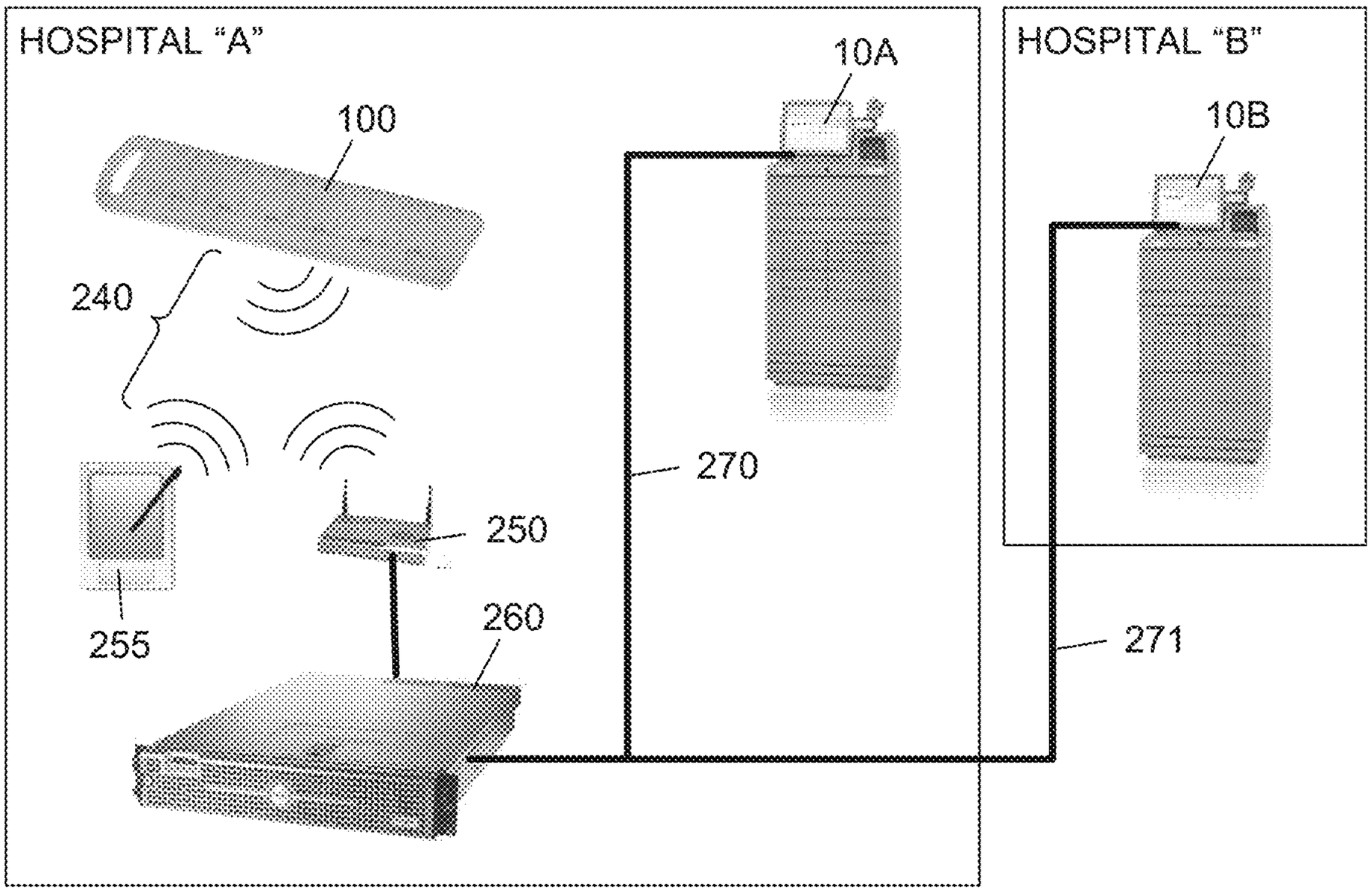
HOSPITAL "A"
100
240
250
255
260
10A
270
HOSPITAL "B"
10B
271

FIG. 6

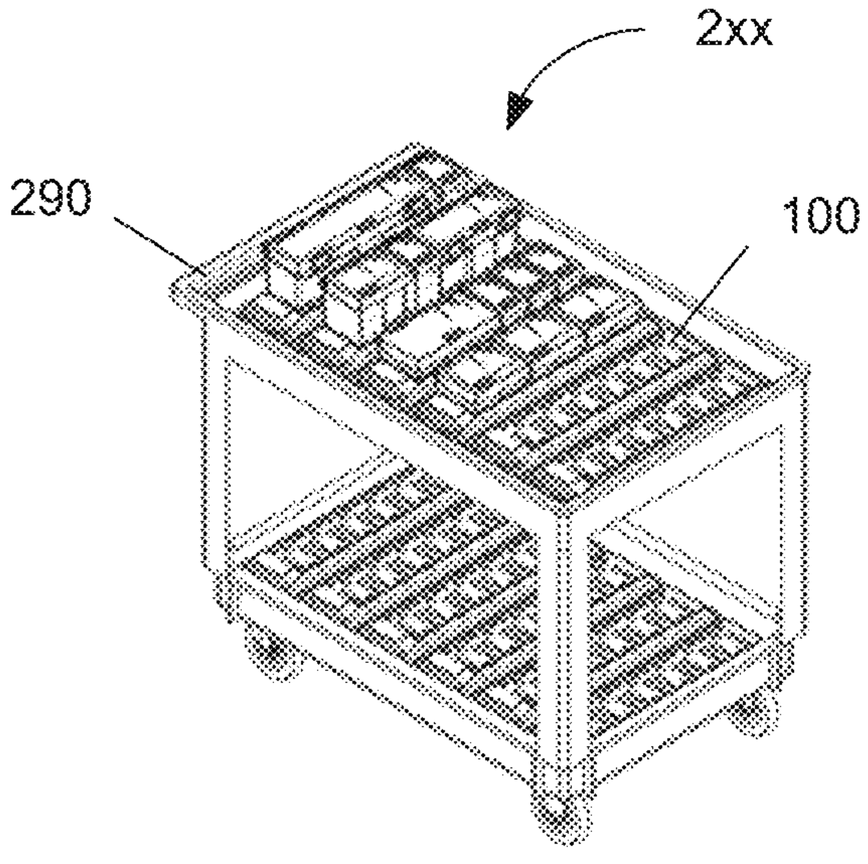
2xx
290
100

FIG. 7

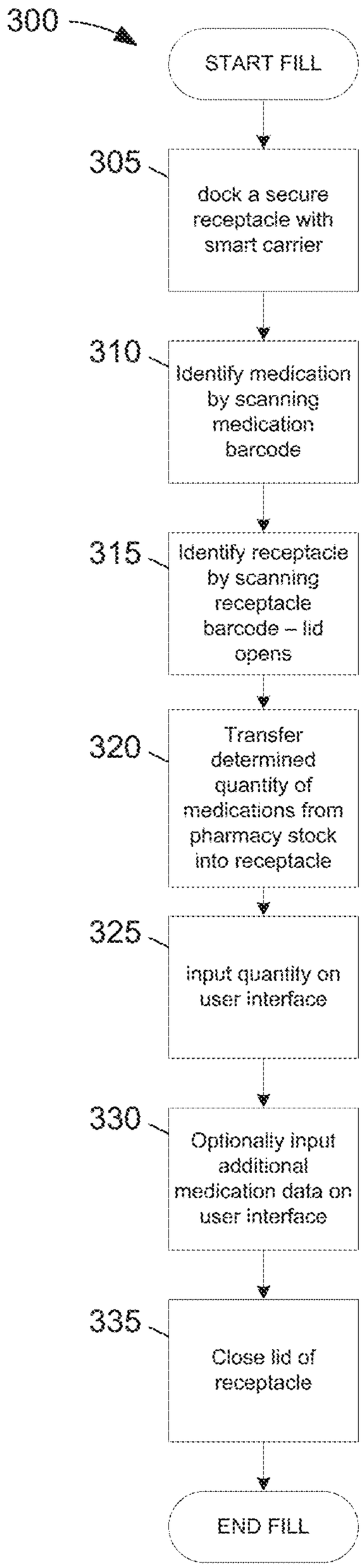
300
START FILL
305
dock a secure receptacle with smart carrier
310
Identify medication by scanning medication barcode
315
Identify receptacle by scanning receptacle barcode – lid opens
320
Transfer determined quantity of medications from pharmacy stock into receptacle
325
input quantity on user interface
330
Optionally input additional medication data on user interface
335
Close lid of receptacle
END FILL

FIG. 8

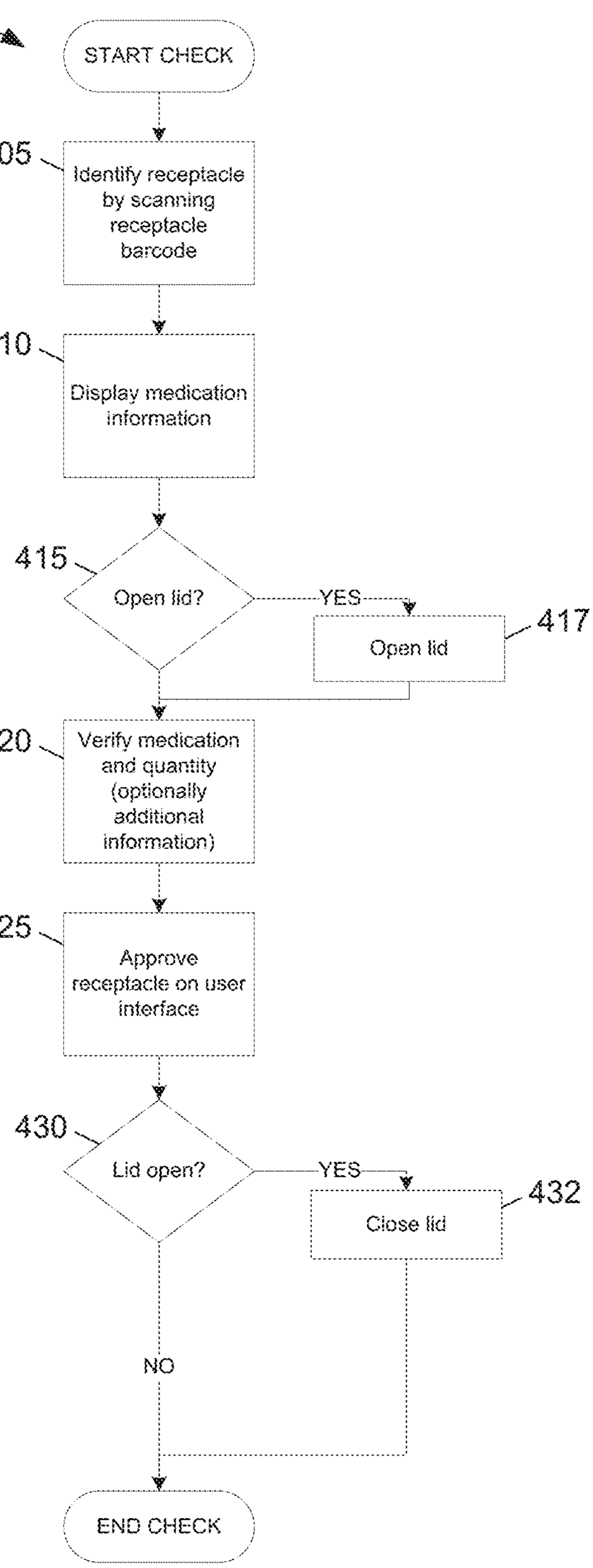
400
START CHECK
405
Identify receptacle by scanning receptacle barcode
410
Display medication information
415
Open lid?
YES
417
Open lid
420
Verify medication and quantity (optionally additional information)
425
Approve receptacle on user interface
430
Lid open?
YES
432
Close lid
NO
END CHECK

FIG. 9

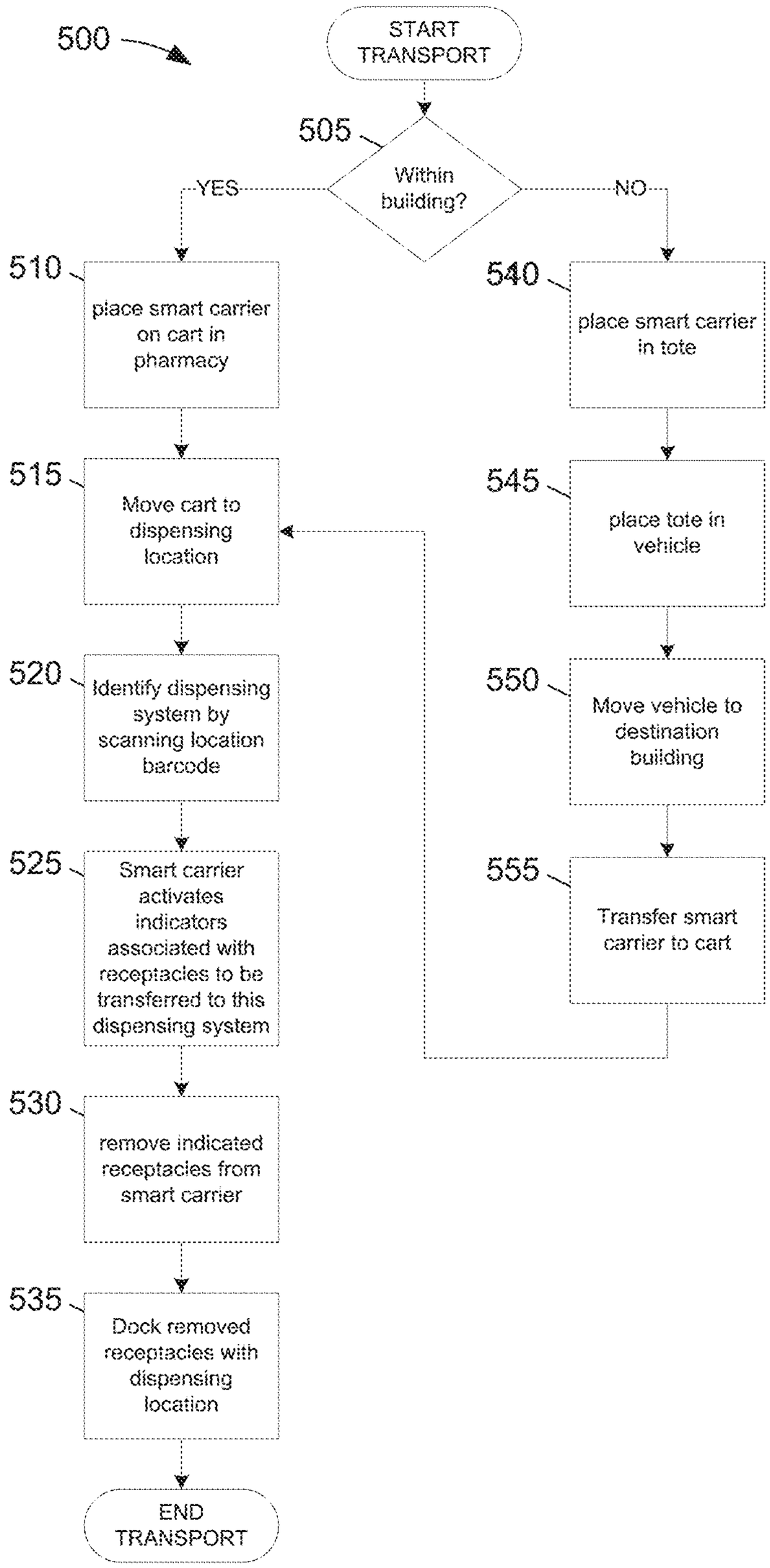
500
START TRANSPORT
505
Within building?
YES
NO
510
place smart carrier on cart in pharmacy
515
Move cart to dispensing location
520
Identify dispensing system by scanning location barcode
525
Smart carrier activates indicators associated with receptacles to be transferred to this dispensing system
530
remove indicated receptacles from smart carrier
535
Dock removed receptacles with dispensing location
END TRANSPORT
540
place smart carrier in tote
545
place tote in vehicle
550
Move vehicle to destination building
555
Transfer smart carrier to cart

FIG. 10

SECURE MEDICATION TRANSPORT

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation patent application of patent application Ser. No. 15/432,862, filed on Feb. 14, 2017, which issued on Jun. 11, 2019, as U.S. Pat. No. 10,318,713 entitled "SECURE MEDICATION TRANSPORT," which is related to and claims priority as a divisional application of, application number Ser. No. 13/931,623, filed on Jun. 28, 2013, which issued on Mar. 21, 2017, as U.S. Pat. No. 9,600,634 entitled "SECURE MEDICATION TRANSPORT," by Gary Bell, et-al. the contents of which are hereby incorporated by reference in their entirety, for all purposes.

BACKGROUND

Field

The present disclosure generally relates to the transport of medications and, in particular, transfer of medications from a pharmacy to a dispensing system.

Description of the Related Art

Patients are routinely prescribed a number of medications while in a hospital. Many hospitals utilize automated dispensing machines (ADMs) to securely store and dispense medications at sites, for example a nursing station, that are remote from the pharmacy. While certain medications are stocked in the ADMs, it is necessary to replenish the stock of medications on a regular basis. In addition, as most ADMs do not have the capacity to store all possible medications, a doctor may prescribe a medication that is not currently stocked in the local ADM and the pharmacy must send this medication to the ADM. Thus, there is a regular transfer of medications from the pharmacy to multiple ADMs within the hospital or, in certain circumstances, to ADMs located in other hospitals.

One method of transferring medications from the pharmacy to an ADM is disclosed in U.S. Pat. No. 6,116,461 to Broadfield et al (hereinafter "the '461 patent"), which is incorporated herein in its entirety. The '461 patent discloses a receptacle with a lid that is held in a closed position, thereby securing the contents of the receptacle, by an internal latch controlled by an internal processor. When the receptacle is docked with a suitable receiving station, such as an ADM, the internal processor is placed in communication with a processor in the receiving station that is further linked to a central data system containing information about medications. The processor of the receiving station may send commands to the internal processor of the receptacle to activate the latch, thereby allowing the lib to be opened. Medications can be transferred from the pharmacy to an ADM by docking a receptacle with a "refill station" in the pharmacy. The '461 patent discloses a process in which the pharmacist or other operator scans a barcode associated with a medication, enters information such as a quantity and expiration date, prints a label that may include medication information in text or barcode form, places the medications in a receptacle and attaches the label to the receptacle, closes the lib, and removes the receptacle from the refill station. The filled receptacle is then placed in a tote and transported to the ADM, the ADM is opened, and the receptacle is docked with the ADM, thereby making the medication available for dispensing from the ADM. One aspect of this system is that the receptacle can be opened only at fixed stations such as a filling station in the pharmacy or the ADM at the nurses' station.

Another conventional method of transferring medications is a manual process wherein medications are placed loose or in plastic bags in totes along with routing sheets. Although most hospitals are taking precautions to separate look-alike/sound-alike medications in compliance with National Patient Safety Goals, there is still opportunity for error as there are thousands of doses of medications available. During the check process, the picked medications are reviewed by scanning the label on the bag and displaying information related to the contents of the bag on a screen for the checker to approve. These medications are collected in totes that are then placed on a mobile cart for transport to the ADM. There is a risk, however, that a tote could be placed directly on the cart and thereby removing medications from the pharmacy without being checked. Furthermore, the medications have the potential to be separated from their routing sheets during handling.

SUMMARY

It is advantageous to provide a mobile carrier that provides power and a communication link to secure receptacles such that the secure receptacles may be filled, checked, and operated at locations other than fixed filling and dispensing systems.

In certain embodiments, a smart carrier is disclosed that has a housing comprising one or more docking locations configured to accept a secure receptacle, a wireless interface module disposed within the housing, and a processor disposed within the housing and operatively coupled to the one or more docking locations and the wireless interface module. The processor is configured to communicate with an external device through the wireless interface module and with a secure receptacle that is mated with one of the one or more docking locations. The smart carrier also has a battery disposed within the housing and configured to provide all operational power to the processor, the wireless interface module, and the one or more docking locations.

In certain embodiments, a system is disclosed that includes a secure receptacle having a body and a lib movable coupled to the body. The lib has a closed position that cooperates with the body to define a compartment. The receptacle also has a lib-securing actuator coupled to the body and configured to engage the lib so as to secure the lib in the closed position when not actuated and to release the lib when actuated. The receptacle also has a processor operatively coupled to the lib-securing actuator. The processor is configured to receive a message and to selectably actuate the lib-securing actuator. The system also includes a smart carrier having a housing comprising one or more docking locations configured to accept the secure receptacle, a wireless interface module disposed within the housing, and a processor disposed within the housing and operatively coupled to the one or more docking locations and the wireless interface module. The processor is configured to communicate with an external device through the wireless interface module and with the processor of a secure receptacle that is mated with one of the one or more docking locations. The smart carrier also has a battery disposed within the housing and configured to provide all operational power to the processor, the wireless interface module, and the one or more docking locations.

In certain embodiments, a method is disclosed that includes the steps of mating a secure receptacle with a

portable smart carrier thereby providing power to the secure receptacle from a battery that is disposed within the smart carrier, the battery also providing all operational power to a wireless interface module and a carrier processor that is coupled to the wireless interface module, scanning with a portable user interface device (PUID) a first machine-readable identifier that is associated with a medication, and identifying the mated secure receptacle by scanning with the PUID a second machine-readable identifier disposed on the secure receptacle. The secure receptacle comprises a memory containing a reference identifier and the second machine-readable identifier is associated with the reference identifier in a database. The method also includes the steps of associating the medication with the reference identifier and loading at least one dose of the medication into the secure receptacle.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide further understanding and are incorporated in and constitute a part of this specification, illustrate disclosed embodiments and together with the description serve to explain the principles of the disclosed embodiments. In the drawings:

FIG. **1**. depicts an example dispensing system.

FIG. **2** depicts an open drawer of the ADM of FIG. **1** and the conventional receptacles contained therein.

FIG. **3** depicts an exemplary smart carrier according to certain aspects of the present disclosure.

FIG. **4**A depicts a plurality of exemplary secure receptacles attached to a smart carrier according to certain aspects of the present disclosure.

FIG. **4**B depicts the corresponding features of another embodiment of a secure receptacle and another embodiment of a smart carrier according to certain aspects of the present disclosure.

FIG. **4**C is a partially exploded view of another secure receptacle **201** according to certain aspects of the present disclosure.

FIG. **5** is a block diagram of an exemplary smart carrier according to certain aspects of the present disclosure.

FIG. **6** is a schematic representation of an exemplary network according to certain aspects of the present disclosure.

FIG. **7** depicts an exemplary cart with a plurality of smart carriers and secure receptacles according to certain aspects of the present disclosure.

FIG. **8** is a flow chart of an exemplary fill process according to certain aspects of the present disclosure.

FIG. **9** is a flow chart of an exemplary check process according to certain aspects of the present disclosure.

FIG. **10** is a flow chart of an exemplary transport process according to certain aspects of the present disclosure.

DETAILED DESCRIPTION

It is advantageous to provide a mobile carrier that provides power and a communication link to secure receptacles such that the secure receptacles may be filled, checked, and operated at locations other than fixed filling and dispensing systems.

The disclosed systems and methods of secure medication transport automate the pick-check-delivery process to provide increased security during medication replenishment throughout a hospital as well as remote site locations.

In the following detailed description, numerous specific details are set forth to provide a full understanding of the present disclosure. It will be apparent, however, to one ordinarily skilled in the art that embodiments of the present disclosure may be practiced without some of the specific details. In other instances, well-known structures and techniques have not been shown in detail so as not to obscure the disclosure. In the referenced drawings, like numbered elements are the same or essentially similar. Reference numbers may have letter suffixes appended to indicate separate instances of a common element while being referred to generically by the same number without a suffix letter.

While the discussion herein is directed to the management of medications in a hospital, the disclosed concepts and methods may be applied to other fields that would also benefit from a secure method of distribution and dispensing. For example, valuable tools may be managed with this system in a service facility.

Within this document, the term "battery" means energy storage devices conventionally referred to as batteries, for example non-rechargeable carbon batteries and rechargeable nickel-cadmium batteries, as well as all other types of portable power source, including but not limited to energy storage devices, such as a capacitor, energy conversion devices, such as a photovoltaic cell, and energy generation devices, such as a fuel cell, or combinations thereof.

Within this document, the phrases "portable user interface device" and "PUID" mean any mobile device that provides information and accepts input. A PUID may provide information via any channel including but not limited to an optical display such as a light-emitting diode (LED) screen and an audible actuator such as a speaker or buzzer. A PUID may accept input via any channel including but not limited to an optical scanner, a radio-frequency identification (RFID) reader including electric-field and magnetic-field systems, a keyboard, a touchscreen or stylus-activated screen, a microphone, and a joystick. PUIDs may include but are not limited to tablet computers, laptop computers, desktop computers installed on a mobile platform, personal data assistants (PDAs), cellular phones, wirelessly connected devices such as iPods and iPads, and readers such as Kindle e-readers.

Within this document, the term "medication" comprises substances that are conventionally considered to be medications, particularly substances that are available only by a doctor's prescription, as well as any other substance or mixture that may be used in a health-related treatment of a patient. Medications include but are not limited to medical fluids such as a saline solution or Ringer's lactate, active compounds such as an analgesic and an antimicrobial, and health-related substances such as a vitamin.

Within this document, the term "scanning" means the input of a machine-readable feature and interpretation of the information encoded therein. Scanning may include passive optical observation and recording of a visual image, such as a barcode or 2D coded matrix, or may include active illumination, such as provision of a light beam that traverses a portion of the image, as is commonly done in a barcode scanner. Scanning may also include provision of an energizing field, such as an electric field or magnetic field as are commonly provided to read passive RFID tags.

Within this document, the term "portable" means a size and weight that is easily moved by an adult. While an object of any size and weight can be moved, with the use of appropriate equipment, a portable device as considered herein would include devices of a size and weight that they would not be burdensome to a person to keep with them for

several hours over the course of an 8-hour workday. Portable devices may be mounted on a rolling cart or other movable appliance, such as the wheeled computer platforms commonly used in hospitals and known to those of skill in the art. Portable devices are not secured to a single location for extended periods of time during which the devices are used.

FIG. **1**. depicts an example dispensing system **10**. This system **10** includes an ADM **12** with a plurality of drawers **15** connected to an auxiliary cabinet **14** having a plurality of drawers **15** and a tall auxiliary cabinet **16** with a plurality of doors **17** and shelves **18**. In one mode of operation, the drawers **15** and doors **17** are secured such that the contents are not available for removal. The ADM **12** includes a user interface **13** and a processor (not visible in FIG. **1**) that accepts input from the user through the user interface **13**. An example dispensing process would begin with a user identifying themselves to the ADM **12**, for example by providing a login name and password through the user interface **13**. The ADM processor verifies that the identified user is authorized to remove at least one item from the ADM **12**, or attached auxiliary cabinets **14** and **16**, and activates an item-selection display. The user selects an item to be dispensed. The ADM processor verifies that the user is authorized to remove the selected item and unlocks the drawer **15** or door **17** that contains the selected item. The user removes the item, closes the drawer **15** or door **17**, and logs out, whereupon the ADM **12** locks the opened drawer **15** or door **17**.

FIG. **2** depicts an open drawer **20** of the ADM **12** of FIG. **1** and the conventional receptacles **30** contained therein. The receptacles **30** are as disclosed in the '461 patent and are marked with a label **32** that is printed at the time of filling of the receptacle **30**. The label **32** includes text **34** that provides information regarding the medication contained in the receptacle **30**, for example the medication name, dose, and expiration date. The label **32** also includes a barcode **36** that may contain a portion of the same information or additional information, such as a tracking number associated with the latest filling of this particular receptacle **30**. The receptacle **30** may also include a non-volatile memory (not visible in FIG. **2**) that stores a unique identification number associated with this receptacle **30**. When the receptacle **30** is plugged into the drawer **20**, the ADM processor of the ADM **12** can communicate with the memory of the receptacle **30** and retrieve the identification number associated with this receptacle **30**. In some systems, a central database (not shown in FIG. **2**) contains a list of identification numbers and information regarding the contents of the respective receptacles **30** and the ADM **12** can communicate with this database to retrieve this information. Thus, plugging a receptacle **30** into the drawer **20** informs the processor of the ADM **12** of the contents of that receptacle **30**.

FIG. **3** depicts an exemplary portable smart carrier **100** according to certain aspects of the present disclosure. This embodiment of the smart carrier **100** comprises a body **102** with a handle **104**, a plurality of docking locations **106**, a processor **120** (not visible in FIG. **3**, shown in FIG. **5**), and an external connector **108**. In general, the smart carrier **100** is sized to be portable and easily carried, for example by the handle **104**, and transported, for example on a cart. Each of the docking locations **106** comprises a connector **110**, a retention feature **112**, and an indicator **114**. In certain embodiments, the connector **110** includes electrical contacts (not visible in FIG. **3**) that may provide one or more of power, ground, and communication lines. In certain embodiments, the retention feature **112** comprises a detent element (not visible in FIG. **3**) that retains a latching feature of a secure receptacle (not shown in FIG. **3**) until the applied removal force exceeds a predetermined value. In certain embodiments, the retention feature **112** comprises a locking element (not visible in FIG. **3**) that retains a latching feature of a secure receptacle (not shown in FIG. **3**) until the locking element is unlocked by a command from the processor **120**. In certain embodiments, the indicator **114** comprises a visual indicator, for example a light-emitting diode (LED). Additional features and capabilities of the smart carrier **100** are discussed with respect to FIG. **5**.

FIG. **4**A depicts a plurality of exemplary secure receptacles 2××, referring generically to all configurations of secure receptacles that may come in various sizes, attached to a smart carrier **100** according to certain aspects of the present disclosure. The example smart carrier **100** of FIG. **3** has six docking locations **106**, each configured to accept a "one wide" or "1×" secure receptacle **200**, as shown in FIG. **4**A wherein a 1× secure receptacle **200** is docked in the third docking location **106** from the handle **104**.

Larger secure receptacles 2×× may occupy two or more adjacent docking locations **106**. For example, a "two-wide" or "2×" secure receptacle **220** is shown docked in the first and second docking locations **106**. Similarly, a "three-wide" or "3×" secure receptacle **230** is shown docked to the fourth, fifth, and sixth docking locations **106**. In this example, the secure receptacle **230** is in operative contact only with the contact **110** of the fifth docking location **106**, as the contacts **110** of the fourth and sixth docking locations **106** are exposed with the secure receptacle **230** in place. In certain embodiments, the secure receptacle **230** may engage only the retention feature **112** of the fifth docking location **106**, while in other embodiments the secure receptacle **230** may engage one or both of the retention features **112** of the fourth and sixth docking locations **106**.

FIG. **4**B depicts the corresponding features of another embodiment of a secure receptacle **200** and another embodiment **100**A of a smart carrier according to certain aspects of the present disclosure. Two 1× secure receptacles **200**A and **200**B are shown as docked in the first and second docking locations that are identical and are designated **106**A and **106**B for convenient specific identification. A third 1× secure receptacle **200**C is shown in an orientation that exposes the features that mate with elements of a docking location **106**, and the specific docking location **106**D is used herein as an example of such. The secure receptacle **200**C has a body **213** with a pair of front feet **216** that include a shaped surface **216-1** and a pair of rear feet **218**. The rear feet **218** fit into the pockets **118** and the front feet **216** fit into the recesses **116** when the secure receptacle **200**C is mated with docking location **106**D. In this embodiment, the recesses **116** are formed such that one of the front feet **216** of adjacent secure receptacles 2×× fit into a common recess **116** while the pockets **118** are configured to accept individual rear feet **218**. In other embodiments, the pockets **118** and recesses **116** may be provided in other configurations to accept single or multiple feet from one or multiple secure receptacles.

There is an interface connector **210** that will mate with docking connector **110** when the secure receptacle **200**C is docked with docking location **106**D. There is also a latching feature **212** on the body **213** that engages a retention feature **112** of the smart carrier **100**A. In certain embodiments, the interface connector **210** and docking connector **110** may be replaced with a wireless communication link, for example inductively coupled plates, that allow communication and power to be transferred between the smart carrier **100** and secure receptacle **200** without direct electrical contact.

FIG. **4**C is a partially exploded view of another secure receptacle **201** according to certain aspects of the present disclosure. Secure receptacle **201** is a "half-height" version of the 1× "full height" secure receptacle **200** shown in FIGS. **4**A and **4**B, wherein the width and depth of the secure receptacles **200** and **201** are the same, and the features shown in FIG. **4**B are common and identical for both, while the height of the secure receptacle **201** is less than the height of the secure receptacle **200**. The lib **211** is movably coupled to the body **213** and, in certain embodiments, the lib **211** is hingedly attached to the body **213** at a back edge of the body **213**. In certain embodiments, the lib **211** is the same on a half-height secure receptacle **201** and a full-height secure receptacle **200** of the same width and depth.

A front cover has been removed from the body **213** to expose certain internal elements, including a processor **219** and a lib-securing actuator **217** that is configured to engage a latching feature such as the hook **211-1** of the lib **211**. In certain embodiments, the lib-securing actuator **217** is configured to engage and retain the hook **211-1** so as to secure the lib **211** in a closed position, for example as shown by secure receptacle **200**A in FIG. **4**B. The processor **219** is operatively coupled to the lib-retaining actuator **217** and the interface connector **110** (not visible in FIG. **4**C). When the lib **211** is closed, the lib **211** cooperates with the body **213** to define a compartment **215**. After the lib is closed, any items placed in the compartment **215** are secure until the secure receptacle **200** is docked with a receiving station such as a smart carrier **100** and a command is received by the processor **219** through the interface connector **210** to open the lib, whereupon the processor actuates the lib-retaining actuator **217** which releases the hook **211-1** and allows the lib **211** to open. In certain embodiments, the secure receptacle **201** may comprise a biasing element, such as a spring, that urges the lib **211** to move away from the closed position to an open position such that the lib **211** will self-open upon release of the hook **211-1** by the lib-securing actuator **217**.

FIG. **5** is a block diagram of an exemplary smart carrier **100** according to certain aspects of the present disclosure. There may be one or more docking locations **106** in a smart carrier **100**, wherein each docking location **106** may have a connector **110**, a retention feature **112**, and an indicator **114**. A processor **120** is operatively coupled to the connectors **110** and the indicators **114**. The processor **120** is also coupled to a memory **128**, a wireless interface module **122**, a wired interface module **124**, and an external connector **108**.

In certain embodiments, the wireless interface **122** is configured to bidirectionally communicate with a wireless network (shown in FIG. **6**), for example an 802.11 network, and communicate with an external device (shown in FIG. **6**) through the network. In certain embodiments, the wired interface module **124** is configured to communicate with a wired network, for example an Ethernet network, through the external connector **108** and communicate with an external device through the network. The smart carrier **100** also comprises a battery **126**, or other portable power source, that may be operatively coupled to the external connector **108**, for example to accept recharging current, and provides all operational power to the elements of the smart carrier **100**. In certain embodiments, the battery **126** may not be coupled to the external connector **108** and must be periodically replaced. The battery **126** is operatively coupled to at least one of the processor **120**, wireless interface module **122**, wired interface module **123**, connectors **110**, and indicators **114**, although these connections have been omitted in FIG. **5** for clarity as the distribution of power in an electronics system will be known to those of skill in the art.

In certain embodiments, the memory **128** is configured to store a carrier identifier that is associated with the individual smart carrier **100**. When a secure receptacle 2×× is docked with one of the docking locations **106**, the processor **120** may communicate with the processor **219** of the secure receptacle 2×× and retrieve a reference identifier that is associated with the individual secure receptacle 2××. The processor **120** may then send the reference identifier of the secure receptacle **200** and the carrier identifier to a server, though either the wired interface module **124** or the wireless interface module **122**, such that the server knows that this particular secure receptacle 2×× is operatively docked with this particular smart carrier **100**.

The processor **120** may also be configured to monitor the condition of the battery **126**, for example one or more of the current state of charge, the provided voltage, the elapsed time since replacement, and the number of recharge cycles, and report one or more of these parameters to an external device.

Upon receipt of certain commands, for example a command to move a docked secure receptacle **200** from the smart carrier **100** to an ADM **12**, the processor may activate an indicator **114** associated with one of the docking locations **106**.

FIG. **6** is a schematic representation of an exemplary network **240**,**270** according to certain aspects of the present disclosure. There is a server **260** located in a "hospital A" that is attached to a wired network **270** and a wireless network **240** through an access point **250**. A dispensing system **10**A in the same building as the server **260** is also connected to the wired network **270** and in communication with the server **260**. The server **260** includes a memory (not visible in FIG. **6**) that is configured to store operating instructions and one or more databases. At least one of the databases includes a listing of the reference identifiers that are associated with secure receptacles **200** that are in use within the hospital A. This database or other databases may include a list of patients and their locations, which may be part of or related to an "admit-discharge-move" or "ADM" system, and a list of prescribed medications.

Once a secure receptacle **200** is filled with a certain number of doses of a medication, the database of the server **260** may store information about the contents of the secure receptacle **200** in association with the reference identifier, which is the sole element of information stored in the processor **219** of the secure receptacle **200**, thereby treating the reference identifier similar to a "license plate" wherein the reference identifier does not contain any information about the contents of the secure receptacle **200** but can be used to access this information in the database of the server **260**. In other embodiments, a copy of a portion of the information that is stored in the database of the server **260** may be copied into a memory of the processor **219** of the secure receptacle **200** such that a recipient device, for example a dispensing system **10**, may retrieve the information about the contents of the secure receptacle **200** from the processor **219** without a need to communicate with the sever **260**.

FIG. **6** also shows a portable user interface device (PUID) **255** that may be used in conjunction with the smart carrier **100**. Example processes are shown in FIGS. **8**-**10**. The PUID **255**, shown in FIG. **6** as a stylus-activated tablet, may be wirelessly connected through the wireless network **240** and access point **250** to the server **260** and can provide input from the user as well as receive and display information sent from by the server **260** to the PUID **255**. The PUID **255** may include the ability to scan and interpret machine-readable

identifiers, for example a barcode or 2D code, as may be used to identify a medication or a device. In certain embodiments, the PUID **255** does not interact directly with a smart carrier **100**. In other embodiments, a PUID **255** be provided with a reference identifier of a smart carrier **100**, for example by scanning a carrier identifier that is available as a barcode attached to the smart carrier **100** and sending this scanned carrier identifier to the server **260**, which responds with the reference identifier associated with the scanned carrier identifier and thereby enables the PUID **255** to interact directly with the smart carrier **100**. In other embodiments, a PUID **255** may be linked to a local smart carrier **100** through a process similar to pairing of Bluetooth® devices as is known to those of skill in the art.

The server **260** may also be connected to dispensing system **10**B located in another building, for example a hospital "B." The wired network **271** that connects to the other building may include a dedicated line, such as a T1 line, between hospitals A and B or an intermittent connection, for example through the internet.

For an example of an order to deliver a medication to a specific dispensing system **10**, the server **260** can exchange information with the PUID **255** as part of the filling process **300**, discussed in greater detail with respect to FIG. **8**, and then provide the destination dispensing system **10** with information related to the secure receptacle **200** that contains the medication to be delivered to that dispensing system **10**.

FIG. **7** depicts an exemplary cart **290** with a plurality of smart carriers **100** and secure receptacles **200** according to certain aspects of the present disclosure. As the smart carriers **100** are portable and self-contained, i.e. can function while separated from any source of power, a cart **290** is a convenient way to carry and use multiple smart carriers **100**. In certain embodiments, the cart **290** may be configured to pass through stock shelves within a pharmacy so as to enable a pharmacy technician to fill secure receptacles **200** at the storage location of a medication, rather than having to carry multiple doses of the medication to a fixed filling station within the pharmacy. In certain embodiments, the cart may be configured to transfer the secure receptacles 2×× from the pharmacy to one or more dispensing systems, for example the dispensing system **10** of FIG. **1**. In certain embodiments, the cart **290** may comprise storage features such as drawers, storages compartments with doors, or other storage arrangements as will be known to those of skill in the art. In certain embodiments, one or more of these storage features may be lockable as will be known to those of skill in the art, thereby providing secure storage during transport.

FIG. **8** is a flow chart of an exemplary fill process **300** according to certain aspects of the present disclosure. The process will be described with reference to the smart carrier **100** and secure receptacle **200** for convenience, although it will apparent to those of skill in the art how similar processes may be accomplished with alternate embodiments of either device. The process starts at step **305** when a user, for example a pharmacy technician, docks a secure receptacle **200** with one of the docking locations **106** of a secure carrier **100**. The processor **120** of the smart carrier **100** establishes communication with the processor **219** of the secure receptacle **200** and retrieves a reference identifier from the processor **219**. The processor **120** sends this reference identifier to a server **260**. The user then uses a PUID **255** in step **310** to scan a machine-readable medication identifier, for example a barcode, that is associated with a medication, for example printed on a container of the medication. The user then uses the PUID **255** in step **315** to scan a machine-readable receptacle identifier, for example a barcode, that is associated with the docked secure receptacle **200**, for example printed on the lib **112** of the secure receptacle **200**. The PUID **255** provides the medication and receptacle identifiers to the server **260**, which compares the receptacle identifier to a list of associated reference identifiers and receptacle identifiers, for example a list contained in a database stored in a memory attached to the server **260**. The server **260** determines the reference identifier that is associated with the provided receptacle identifier and creates a fill record in the database that the identified secure receptacle **200** that is associated with the provided receptacle identifier is being filled with the medication associated with the provided medication identifier.

As part of step **315**, the server **260** sends a "lib open" command to the processor **120** to open the lib **112** of the docked secure receptacle **200**. The processor **120** sends a command to the processor **219** to open the lib **112**, and the processor **219** actuates the lib-securing actuator **217**, thereby releasing the lib **112** that, in this example, self-opens under the urging of a spring. The user proceeds to step **320** and transfers a determined quantity of the medication into the compartment **215** of the secure receptacle **200**, inputs the quantity transferred into the PUID **255** in step **325** and optionally enters additional information, for example an expiration date, in step **330**. The PUID **255** sends this information to the server **260**, which updates the previously created fill record. The user then closes the lib **112** in step **335**, whereupon the processor **219** sends a signal to the processor **120** that the lib **112** is closed. The processor **120** forwards this information to the server **260**, which closes the fill record as complete, thereby completing the fill process **300**.

FIG. **9** is a flow chart of an exemplary check process **400** according to certain aspects of the present disclosure. For this example, it is presumed that the check process **400** follows the fill process **300** and that the secure receptacle **200** is still attached to the smart carrier **100**. The process starts at step **405** when a user, for example a licensed pharmacist, uses the PUID **255** to scan the machine-readable receptacle identifier on the docked secure receptacle **200**. The PUID **255** sends the receptacle identifier to the server **260**, which retrieves the fill record and sends this information to the PUID **255**, which displays this information in step **410**. If the user wishes to open the lib **112** to directly inspect the medications in the compartment **215**, the user may optionally input a command into the PUID in step **415** to open the lib **112**, whereupon the PUID **255** send the request to the server **260** that sends a "lib open" to the processor **120**, in turn sends a command to the processor **219** to open the lib **112**, and the processor **219** actuates the lib-securing actuator **217**, thereby releasing the lib **112** in step **417**. After the user verifies in step **420** that the secure receptacle **200** contains the proper quantity of the proper medication, and optionally other information, the user inputs an approval on the PUID **255** in step **425**, whereupon the PUID **255** sends the approval to the server **260** which annotates the fill record to indicate that the fill was checked and approved. If the lib **112** was opened, the process branches at decision point **430** and the user closes the lib **112** in step **432**, thereby completing the check process **400**.

FIG. **10** is a flow chart of an exemplary transport process **500** according to certain aspects of the present disclosure. For this example, it is presumed that the transport process **500** follows the check process **400** and that the secure receptacle **200** is still attached to the smart carrier **100**. The process starts at step **505** when a user, for example a pharmacy technician, picks up a smart carrier **100** with a

secure receptacle **200** docked in one of the docking locations **106**. If the destination of the secure receptacle **200** is a dispensing system **10** within the same building, the process **500** branches to step **510** wherein the user places the smart carrier **100** on a cart **290** such as shown in FIG. **7**. In certain embodiments, the destination of a filled secure receptacle **200** may be any of a refrigerated cabinet, a beside storage compartment in a patient's room, an infusion pump or other medical device, or a designated storage location, for example a locked inventory area. The user moves the cart **290** to the location of the dispensing system **10** in step **515** and scans a machine-readable dispenser identifier, for example a barcode, on the dispensing system **10** with the PUID **255**. The PUID **255** sends this dispenser identifier to the server **260**, determines which medications are intended to be loaded into this dispensing system **10**, and then determines which secure receptacles **200** contain these medications and the reference identifiers of those receptacles **200**.

For this example, a single medication is intended to be delivered to this dispensing system **10** and the server **260** sends the reference identifier to the processor **120** of the smart carrier **100** to which the determined secure receptacle **20** is docked. In step **525**, the processor **120** activates the indicator **114** that is associated with the docking location **106** to which the determined secure receptacle **200** is docked. In step **530**, the user removes the secure receptacle from the docking location **106** having the activated indicator **114** and, in step **535**, docks the removed secure receptacle **200** with the dispensing system **10**, thus terminating the transport process **500** for this secure receptacle **200**. Step **535** may include additional activities to log into the dispensing system **10** and open the storage location, for example a drawer, prior to docking the secure receptacle **200**. The user may then repeat steps **515-535** to deliver other secure receptacles **200** to other dispensing systems **10** in the same building.

If, in step **505**, the user determines that the secure carrier **100** has secure receptacles **200** that are to be delivered to a dispensing system **10** in another building, for example a hospital "B" as shown in FIG. **6**, that is part of a group of hospitals, then the process **500** branches to step **540** and the user places the smart carrier **100** in a tote or other transport container. The user places the tote in a vehicle, for example a van, in step **545** and a driver, which may be the same user or a different person, moves the vehicle to the destination building, e.g. the other hospital, in step **550**. In step **555**, the driver, or another user such as a pharmacy technician, transfers the smart carrier **100** from the tote to a cart **290**. This branch of process **500** then follows the steps **515-535** within this second building to complete the process.

It can be seen that the disclosed embodiments of the smart carrier, in conjunction with secure receptacles and a mobile input device, allow a pharmacist to dispense and transport medication with greater ease and improved safety but allowing them to move the disclosed systems to the location of the medications, or other convenient work locations, and not be limited by a fixed location, for example a filling station located in a fixed location in a pharmacy. The linkage of the various disclosed systems also provides improved record-keeping as the information is immediately provided to and stored by a central server.

The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. While the foregoing has described what are considered to be the best mode and/or other examples, it is understood that various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. Thus, the claims are not intended to be limited to the aspects shown herein, but is to be accorded the full scope consistent with the language claims, wherein reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more." Unless specifically stated otherwise, the terms "a set" and "some" refer to one or more. Pronouns in the masculine (e.g., his) include the feminine and neuter gender (e.g., her and its) and vice versa. Headings and subheadings, if any, are used for convenience only and do not limit the invention.

To the extent that the terms "include," "have," or the like are used in the description or the claims, such terms are intended to be inclusive in a manner similar to the term "comprise" as "comprise" is interpreted when employed as a transitional word in a claim.

It is understood that the specific order or hierarchy of steps in the processes disclosed is an illustration of exemplary approaches. Based upon design preferences, it is understood that the specific order or hierarchy of steps in the processes may be rearranged. Some of the steps may be performed simultaneously. The accompanying method claims present elements of the various steps in a sample order, and are not meant to be limited to the specific order or hierarchy presented.

Terms such as "top," "bottom," "front," "rear" and the like as used in this disclosure should be understood as referring to an arbitrary frame of reference, rather than to the ordinary gravitational frame of reference. Thus, a top surface, a bottom surface, a front surface, and a rear surface may extend upwardly, downwardly, diagonally, or horizontally in a gravitational frame of reference.

A phrase such as an "aspect" does not imply that such aspect is essential to the subject technology or that such aspect applies to all configurations of the subject technology. A disclosure relating to an aspect may apply to all configurations, or one or more configurations. A phrase such as an aspect may refer to one or more aspects and vice versa. A phrase such as an "embodiment" does not imply that such embodiment is essential to the subject technology or that such embodiment applies to all configurations of the subject technology. A disclosure relating to an embodiment may apply to all embodiments, or one or more embodiments. A phrase such an embodiment may refer to one or more embodiments and vice versa.

The word "exemplary" is used herein to mean "serving as an example or illustration." Any aspect or design described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other aspects or designs.

No claim element is to be construed under the provisions of 35 U.S.C. § 112, sixth paragraph, unless the element is expressly recited using the phrase "means for" or, in the case of a method claim, the element is recited using the phrase "step for."

What is claimed is:

1. A portable carrier comprising:

a housing including a docking location, wherein the docking location includes a retention feature formed to engage with a secure receptacle, the housing configured to be removably coupled to a cart, wherein the cart is configured to couple with a plurality of portable carriers;

an indicator associated with the docking location;

a wireless interface module disposed within the housing;

a processor disposed within the housing and operatively coupled to the docking location and the wireless interface module;

an energy storage device disposed within the housing, the energy storage device electrically coupled with the processor, the wireless interface module, and the docking location to provide operational power; and

wherein the docking location further includes a connector electrically coupled with the energy storage device and arranged to transmit power to the secure receptacle at the docking location,

wherein the processor is configured to:

activate the indicator when the docking location receives the secure receptacle;

receive, via the wireless interface, a command to adjust the secure receptacle; and

cause the secure receptacle to perform an adjustment corresponding to the command.

2. The portable carrier of claim **1**, wherein the command includes a first identifier and wherein the processor is configured to:

retrieve a second identifier from a the secure receptacle that is mated with the docking location; and

cause the secure receptacle to perform the adjustment after determining that the first identifier matches the second identifier.

3. The portable carrier of claim **1**, wherein:

the secure receptacle comprises a body, a lib having a closed position that cooperates with the body to form a compartment, and a lib actuator operatively coupled to the processor, the lib actuator configured to engage the lib when not actuated so as to retain the lib in the closed position and to release the lib when actuated, thereby allowing the lib to open; and

wherein the adjustment includes actuating the lib actuator.

4. The portable carrier of claim **1**, wherein:

the secure receptacle comprises a processor coupled to an interface connector; and

the processor of the portable carrier is in two-way communication with the processor of the secure receptacle through the interface connector and the connector.

5. The portable carrier of claim **1**, further comprising a memory comprising instructions, wherein the processor is configured to retrieve the instructions from the memory and execute the instructions.

6. The portable carrier of claim **1**, wherein the processor is further configured to transmit a command to the secure receptacle to release a securable lib that is movably coupled to a body of the secure receptacle and cooperates with the body to define a compartment within the secure receptacle when the securable lib is in a closed position, thereby allowing access to the compartment, and a dose of a medication in the compartment.

7. The portable carrier of claim **1**, wherein the processor is configured to cause the receptacle to perform the adjustment by at least:

transmitting the command to a docking connector that is coupled with the processor and therethrough to a mated interface connector of the secure receptacle to retain a lib of the secure receptacle in a closed position when not actuated and to release the lib when actuated, thereby allowing the lib to open.

8. The portable carrier of claim **1**, wherein the wireless interface module is communicatively coupled to a server and wherein the processor is configured to:

monitor a state of the energy storage device; and

transmit, via the wireless interface module to the server, a message reporting the state.

9. The portable carrier of claim **8**, wherein the wireless interface module is configured to:

provide an identifier for the secure receptacle to the server;

retrieve a reference identifier from a database; and

access a record in the database and associate a medication with the reference identifier.

10. The portable carrier of claim **1**, wherein the processor is further configured to:

close a lib to secure a dose of a medication in the secure receptacle; and

transmit a message to update a record in a database to indicate that a fill process for the secure receptacle is complete.

11. A system, comprising:

a secure receptacle comprising:

a body;

a lib movably coupled to the body, the lib having a closed position that cooperates with the body to form a compartment; and

a lib actuator configured to engage the lib when not actuated so as to retain the lib in the closed position and to release the lib when actuated, thereby allowing the lib to open; and

a portable carrier comprising:

a housing including a docking location, wherein the docking location includes a retention feature formed to engage with the secure receptacle, the housing configured to be removably coupled to a cart, wherein the cart is configured to couple with a plurality of portable carriers;

an indicator associated with the docking location;

a wireless interface module disposed within the housing;

a processor disposed within the housing and operatively coupled to the docking location, the lib actuator and the wireless interface module; and

wherein the docking location further includes a connector arranged to transmit power to the secure receptacle at the docking location,

wherein the processor is configured to:

activate the indicator when the docking location receives the secure receptacle;

receive, via the wireless interface, a command to adjust the secure receptacle; and

cause the secure receptacle to perform an adjustment corresponding to the command.

12. The system of claim **11**, wherein the command includes a first identifier and wherein the processor is configured to:

retrieve a second identifier from the secure receptacle that is mated with the docking location; and

cause the secure receptacle to perform the adjustment after determining that the first identifier matches the second identifier.

13. The system of claim **11**, wherein the adjustment includes actuating the lib actuator.

14. The system of claim **12**, wherein the processor comprises a memory configured to store the first identifier.

15. The system of claim **12**, further comprising a portable user interface device configured to scan machine-readable identifiers, wherein the secure receptacle comprises a machine-readable feature comprising a third identifier that is associated with the first identifier.

16. The system of claim 11, wherein the portable carrier further comprises a memory comprising instructions, wherein the processor is configured to retrieve the instructions from the memory and execute the instructions.

17. The system of claim 11, wherein:

the secure receptacle comprises a processor coupled to an interface connector; and

the processor of the portable carrier is in two-way communication with the processor of the secure receptacle through the interface connector and the connector.

18. The system of claim 11, wherein the processor is further configured to:

update a record in a database to indicate that the compartment is filled;

scan with the wireless interface module a machine-readable identifier disposed on the secure receptacle;

retrieve, from a record in the database, information related to a medication in the secure receptacle and display the information on a display;

verify that the medication in the secure receptacle matches the record in the database; and

update the record in the database to indicate that a check process is complete.

19. The system of claim 12, wherein the processor is further configured to:

scan with the wireless interface module a third identifier that is associated with a dispensing system;

retrieve, from a database, a reference identifier of the secure receptacle that contains a medication intended to be delivered to the dispensing system that is associated with the third identifier; and

activate an indicator associated with the docking location in which the secure receptacle is docked.

20. The system of claim 19, wherein the processor is further configured to:

remove the secure receptacle from the docking location associated with the indicator;

dock the secure receptacle; and

update a record that a transport process is complete.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 10,777,311 B2
APPLICATION NO. : 16/434631
DATED : September 15, 2020
INVENTOR(S) : Gary Bell et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Specification

Column 1, Line 54: Replace the whole word “lib” with --lid--.

Column 1, Line 63: Replace the whole word “lib” with --lid--.

Column 2, Line 43: Replace the whole word “lib” with --lid--.

Column 2, Line 44: Replace the whole word “lib” with --lid--.

Column 2, Line 46: Replace the whole word “lib-securing” with --lid-securing--.

Column 2, Line 47: Replace both whole words “lib” with --lid--.

Column 2, Line 49: Replace the whole word “lib” with --lid--.

Column 2, Line 50: Replace the whole word “lib-securing” with --lid-securing--.

Column 2, Line 52: Replace the whole word “lib-securing” with --lid-securing--.

Column 7, Line 9: Replace the whole word “lib” with --lid--.

Column 7, Line 10: Replace the whole word “lib” with --lid--.

Column 7, Line 12: Replace the whole word “lib” with --lid--.

Column 7, Line 17: Replace the whole word “lib-securing” with --lid-securing--.

Column 7, Line 18: Replace the whole word “lib” with --lid--.

Signed and Sealed this
Twentieth Day of April, 2021

Drew Hirshfeld
Performing the Functions and Duties of the
Under Secretary of Commerce for Intellectual Property and
Director of the United States Patent and Trademark Office

Column 7, Line 19: Replace the whole word “lib-securing” with --lid-securing--.

Column 7, Line 21: Replace the whole word “lib” with --lid--.

Column 7, Line 23: Replace the whole word “lib-retaining” with --lid-retaining--.

Column 7, Line 25: Replace both whole words “lib” with --lid--.

Column 7, Line 26: Replace the whole word “lib” with --lid--.

Column 7, Line 31: Replace the whole word “lib” with --lid--.

Column 7, Line 31: Replace the whole word “lib-retaining” with --lid-retaining--.

Column 7, Line 33: Replace the whole word “lib” with --lid--.

Column 7, Line 35: Replace the whole word “lib” with --lid--.

Column 7, Line 36: Replace the whole word “lib” with --lid--.

Column 7, Line 37: Replace the whole word “lib-securing” with --lid-securing--.

Column 10, Line 2: Replace the whole word “lib” with --lid--.

Column 10, Line 14: Replace the whole word “lib” with --lid--.

Column 10, Line 15: Replace the whole word “lib” with --lid--.

Column 10, Line 17: Replace the whole word “lib” with --lid--.

Column 10, Line 18: Replace the whole word “lib-securing” with --lid-securing--.

Column 10, Line 19: Replace the whole word “lib” with --lid--.

Column 10, Line 27: Replace the whole word “lib” with --lid--.

Column 10, Line 29: Replace the whole word “lib” with --lid--.

Column 10, Line 44: Replace the whole word “lib” with --lid--.

Column 10, Line 47: Replace the whole word “lib” with --lid--.

Column 10, Line 48: Replace the whole word “lib” with --lid--.

Column 10, Line 49: Replace the whole word “lib” with --lid--.

Column 10, Line 50: Replace the whole word “lib-securing” with --lid-securing--.

Column 10, Line 51: Replace the whole word “lib” with --lid--.

Column 10, Line 57: Replace the whole word “lib” with --lid--.

Column 10, Line 59: Replace the whole word “lib” with --lid--.

In the Claims

Column 13, Line 29 (Claim 3): Replace the whole word “lib” with --lid--.

Column 13, Line 31 (Claim 3): Replace the whole word “lib” with --lid--.

Column 13, Line 32 (Claim 3): Replace the whole word “lib” with --lid--.

Column 13, Line 33 (Claim 3): Replace both whole words “lib” with --lid--.

Column 13, Line 34 (Claim 3): Replace the whole word “lib” with --lid--.

Column 13, Line 35 (Claim 3): Replace the whole word “lib” with --lid--.

Column 13, Line 36 (Claim 3): Replace the whole word “lib” with --lid--.

Column 13, Line 49 (Claim 6): Replace the whole word “lib” with --lid--.

Column 13, Line 52 (Claim 6): Replace the whole word “lib” with --lid--.

Column 13, Line 61 (Claim 7): Replace the whole word “lib” with --lid--.

Column 13, Line 62 (Claim 7): Replace the whole word “lib” with --lid--.

Column 13, Line 63 (Claim 7): Replace the whole word “lib” with --lid--.

Column 14, Line 12 (Claim 10): Replace the whole word “lib” with --lid--.

Column 14, Line 21 (Claim 11): Replace both whole words “lib” with --lid--.

Column 14, Line 24 (Claim 11): Replace both whole words “lib” with --lid--.

Column 14, Line 25 (Claim 11): Replace the whole word “lib” with --lid--.

Column 14, Line 26 (Claim 11): Replace the whole word “lib” with --lid--.

Column 14, Line 27 (Claim 11): Replace the whole word “lib” with --lid--.

Column 14, Line 39 (Claim 11): Replace the whole word “lib” with --lid--.

Column 14, Line 60 (Claim 13): Replace the whole word “lib” with --lid--.